Title

Green Diode Laser

Background of the Present Invention

Field of Invention

The present invention relates to a diode laser, and more particularly to a green diode laser a volume and a weight thereof are significantly reduced with respect to conventional ones.

Description of Related Arts

Diode Pumped Solid State (DPSS) lasers have got increasingly popularly used due to their energy efficiency, high reliability, ruggedness, internal blanking and low Total Cost of Ownership (TCO). Their example applications include laser pointer, machining, material processing, spectroscopy, wafer inspection, light show, medical diagnostics and etc.

A typical green DPSS laser 9 is as schematically shown in Figs. 1a and 1b. The green DPSS laser consists of a laser diode assembly 102 having a case 109 containing a pump diode 102. The pump diode 102, powered by a driver circuit providing current therefor, is attached to a heat sink 101 part of which is also contained in the case 109. The pump diode 102 is an infrared (IR) laser diode emitting at 808 nanometer (nm). Laser beam produced by the pump diode 102 passes through an output window defined in the case 109 and a microlens covering on the window. An optical resonant cavity is provided in the path of the laser beam, having a lasing medium 104 and an intracavity frequency doubler 105, either departuring with each other or optically glued together. If the lasing medium 104 and the intracavity frequency doubler 105 are optically glued together, an anti-reflection coating at 808 nm (AR@808) and a high-reflection coating at 532 (HR@532) nm and HR@1064 nm are applied to an input facet facing the pump diode light, and an HR@1064 and an AR@532 are applied to an output facet opposite to the input facet. When the lasing medium 104 and the intracavity frequency doubler 105 are

discrete, an AR@808 and an HR@1064 are applied to the input facet of the lasing medium 104, and an AR@1064 to an output facet of the lasing medium 104 opposite to the input facet thereof; while an AR@1064 and an AR@532 to an input facet of the intracavity frequency doubler 105 facing the output facet of the lasing medium 104, and an HR@1064 and an AR@532 to an output facet of the intracavity frequency doubler 105 opposite to the input facet thereof.

The lasing medium 104 can be, most often, Nd:YAG or Nd:YVO_4, or another crystal that amplifies the input light that passes through it. The intracavity frequency doubler 105 is usually KTP, KDP, LBO, BBO, ADP, LiIO3, or another non-linear material that is able to efficiently produce an output that is twice the frequency of the signal applied to its input.

Generally, a focusing optics (also known as "circularizing optics", must be inserted between the laser diode assembly and the optical resonant cavity for shaping the laser beam from the pump diode as round as possible.

An infrared (IR) blocking filter is provided in the path of the laser beam for removing the unwanted IR rays while providing excellent transmission for green wavelength. Optically, an electro-optic crystal (also known as Q-switch, 94) and/or a single mode device can also be inserted between the optical resonant cavity (93) and the IR blocking filter respectively for making the laser into a pulse laser and/or a single longitudinal mode laser.

A photodiode is attached in the case of the laser diode assembly for receiving and sensing a reflected laser from the microlens and thus establishing a negative feedback for controlling the optical power output by the pump diode.

Up until now, all conventional diode pumped solid state lasers arrange the optical resonant cavity within a small inner barrel placed in front of the laser diode assembly to form an "external" resonant cavity. The focusing optics, the Q-switch, and/or the single mode device are selectively, as needed, attached to the inner barrel and then installed within a diode laser module along with the laser diode assembly. So, it is thought that if the optical resonant cavity, together with other wanted optics, can be put into within the case of the laser diode assembly before the pump diode, the volume and weight of the whole DPSS laser will thus significantly lowered.

Summary of the Present Invention

A main object of the present invention is to provide a green diode laser, wherein a volume thereof is substantially smaller than the conventional ones.

Another object of the present invention is to provide a green diode laser, wherein a weight thereof is substantially less than the conventional ones.

Accordingly, in order to accomplish the above objects, the present invention provides a green diode laser, comprising:

a tubular laser casing having a first opening end and a second opening end;

a heat sink sealedly mounted at the first opening end of the laser casing;

a green laser chip comprising a semiconductor chip supported by the heat sink for producing a laser beam, a lasing medium supported within the laser casing to communicate with the semiconductor chip, and an intracavity frequency doubler mounted to the lasing medium, wherein an input facet is formed at the lasing medium for the laser beam entering thereinto, an output facet is formed at the intracavity frequency doubler for the laser beam exiting therefrom, an optical resonant cavity is defined between the inner and output facets;

an IR blocking filter inclinedly and sealedly mounted at the second opening end of the laser casing to optically communicate with the output facet; and

a photodiode supported within the laser casing at a position that when the laser beam exits the output fact, the IR blocking filter reflects a portion of the laser beam towards the photodiode such that the photodiode is adapted for detecting the laser beam from the IR blocking filter as a feedback for controlling a power output of the green laser chip.

These and other objectives, features, and advantages of the present invention will become apparent from the following detailed description, the accompanying drawings, and the appended claims.

Brief Description of the Drawings

Figs. 1A and 1B are conventional diode laser.

Figs. 2A and 2B are schematic views of a green diode laser according to a preferred embodiment of the present invention.

Figs. 3A and 3B illustrate a first alternative mode of the green diode laser according to the above preferred embodiment of the present invention.

Fig 4 illustrates a second alternative mode of the green diode laser according to the above preferred embodiment of the present invention.

Fig 5 illustrates a third alternative mode of the green diode laser according to the above preferred embodiment of the present invention.

Fig 6 illustrates a fourth alternative mode of the green diode laser according to the above preferred embodiment of the present invention.

Fig 7 illustrates a fifth alternative mode of the green diode laser according to the above preferred embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Referring to Figs. 2A and 2B, a green diode laser according to a preferred embodiment of the present invention is illustrated, wherein the green diode laser comprises a tubular laser casing 208 having a first opening end and a second opening end, a heat sink 201 sealedly mounted at the first opening end of the laser casing 208.

The green diode laser further comprises a green laser chip (GLC) comprising a semiconductor chip 202 supported by the heat sink 201 for producing a laser beam, a lasing medium 203 supported within the laser casing 208 to communicate with the semiconductor chip 202, and an intracavity frequency doubler 204 mounted to the lasing medium 203, wherein an input facet is formed at the lasing medium for the laser beam entering thereinto, an output facet is formed at the intracavity frequency doubler for the laser beam exiting therefrom as a green laser beam at 532nm, an optical resonant cavity is defined between the inner and output facets.

The green diode laser further comprises an IR blocking filter 205 inclinedly and sealedly mounted at the second opening end of the laser casing 208 to optically communicate with the output facet, and a photodiode 206 supported within the laser casing 208 at a position that when the laser beam exits the output fact, the IR blocking filter 205 reflects a portion of the laser beam towards the photodiode 206 such that the photodiode 206 is adapted for detecting the laser beam from the IR blocking filter 205 as a feedback for controlling a power output of the green laser chip.

The lasing medium 203 can be, most often, Nd:YAG or $Nd:YVO_4$, or another crystal that amplifies the input light that passes through it.

The intracavity frequency doubler 204 is usually KTP, KDP, LBO, BBO, ADP, LiIO3, or another non-linear material that is able to efficiently produce an output that is twice the frequency of the signal applied to its input.

According to the preferred embodiment, a 808nm anti-reflection layer, a 532nm high-reflection layer, and a 1064nm high-reflection layer are respectively coated at the

input facet. A 1064nm high-reflection layer and a 532nm anti-reflection layer are respectively coated at the output facet.

The photodiode 206 has a light detecting surface for receiving the laser beam from the IR blocking filter 205. A 532nm anti-reflection layer, a 808nm high-reflection layer, and a 1064nm high-reflection layer are respectively coated on the light detecting surface of the photodiode 206. Alternatively, a lens filter having a 532nm anti-reflection ability, a 808nm high-reflection and a 1064nm high-reflection ability can be provided at the light detecting surface of the photodiode 206.

As shown in Figs. 3A and 3B, a focusing device 303 is mounted between the semiconductor chip 202 and the input facet for enhancing the laser beam from the semiconductor chip 202.

As shown in Fig. 4, a 808nm anti-reflection layer and a 1064nm high-reflection layer are respectively coated at the input facet of the lasing medium 203 and a 1064nm anti-reflection layer is coated at the output facet of the lasing medium 203.

A 1064nm anti-reflection layer and a 532nm anti-reflection layer are respectively coated at the input facet of the intracavity frequency doubler 204 and a 1064nm high-reflection layer and a 532nm anti-reflection layer are respectively coated at the output facet of the intracavity frequency doubler 204. Therefore, when the laser beam from the semiconductor chip 202 enters into the lasing medium 203 as a red laser at 1064nm, a green laser beam at 532nm is formed and exited from the lasing medium 203.

As shown in Fig. 5, an electro-optic crystal 505, which is also known as Q-switch, is mounted between the semiconductor chip 202 and IR blocking filter 205 within the laser casing 208 for making the laser into a pulse laser. The infrared (IR) blocking filter 206 can be provided in the path of the laser beam closely neighboring a microlens, either within or out of the laser casing 208, for removing the unwanted IR rays while providing excellent transmission for green wavelength. Optically, this IR blocking filter 206 can be dispensed with and the microlens is so made as able to take such a function.

As shown in Fig. 6, a single mode device 605 is mounted between the semiconductor chip 202 and the IR blocking filter 205 within the laser casing for converting the laser into a single longitudinal mode laser.

As shown in Fig. 7, when the intracavity frequency doubler 204 is omitted, a infrared light at 1064nm is output. Accordingly, a 808nm anti-reflection layer and a 1064nm high-reflection layer are respectively coated at the input facet of the lasing medium 203 while a 1064nm high-reflection layer is coated at the output facet of the lasing medium 203. In addition, a 1064nm anti-reflection layer and a 808nm high reflection layer are respectively coated at the light detecting surface of the photodiode 206. Therefore, the photodiode 206 is adapted for detecting the infrared light from the IR blocking filter 205 as a feedback for controlling a power output of the laser chip.

From above disclosure, it could be seen that by installing and supporting the resonant cavity and the necessary optics within the laser casing 208 of an existing green laser chip (GLC), a volume and weight of the present invention will be substantially reduced.

One skilled in the art will understand that the embodiment of the present invention as shown in the drawings and described above is exemplary only and not intended to be limiting.

It will thus be seen that the objects of the present invention have been fully and effectively accomplished. Its embodiments have been shown and described for the purposes of illustrating the functional and structural principles of the present invention and is subject to change without departure from such principles. Therefore, this invention includes all modifications encompassed within the spirit and scope of the following claims.